The validity of monitoring the control of diabetes with random blood glucose testing

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Abstract

It is important to decide if a patient with diabetes has good glycaemic control in order to guide treatment and to offer behaviour change counselling. Currently, determining random blood glucose (RBG) is usually carried out in primary care in the public sector to make this decision. This study investigates the validity of these decisions. Retrospective data from a district hospital setting were used to analyse the correlation between glycated haemoglobin (HbA_{1c}) and RBG, the best predictive value of RBG, and its predictive properties. The best value of RBG to predict control ($HbA_{1c} \leq 7\%$) was 9.8 mmol/l. However, this threshold only gave a sensitivity of 77% and a specificity of 75%. Clinicians would be wrong 23% of the time when using RBG to determine glycaemic control. Attempts should be made to make HbA_{1c} more available for clinical decision-making. Point-of-care testing for HbA_{1c} should be considered.

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Introduction

One of the important clinical decisions that must be made when caring for a person with diabetes is to determine if his or her blood glucose is well controlled. If the patient is uncontrolled, treatment intensification or behaviour change counselling is required. Many of the complications of diabetes can be mitigated or avoided by ensuring good glycaemic control.[1]

Usually, this decision is made by means of a random blood glucose (RBG) test in the public sector. RBG is measured in the health centre by a nurse using a glucometer. The rule of thumb used by many practitioners is that a patient with a RBG of > 10 mmol/l is uncontrolled. However, guidelines recommend the use of glycated haemoglobin (HbA_{1c}) to accurately assess control of blood glucose.[2] An HbA_{1c} of 7% or less is regarded as good control and the goal of treatment. In Cape Town, health workers were recently allowed to order one HbA_{1c} test per year, per patient. Currently, approximately 40% of patients receive this test, and as it must be sent away to the laboratory, it is often not available at the time that a clinical decision needs to be taken.[3]

This study aimed to determine the validity of clinical decisions based on RBG, when compared to the results obtained by HbA_{1c}, in a district hospital setting.

The study was a retrospective analysis of existing hospital and laboratory data. A sample size of 350 was recommended to achieve 80% power to detect a correlation of at least 0.2, using a two-sided hypothesis test with a significance level of 0.05. Data were obtained from the National Health Laboratory Service on HbA_{1c} tests requested by Karl Bremer District Hospital in 2010. The patient records for each of the HbA_{1c} test results were drawn, and the corresponding RBG obtained that was taken in the outpatient department at the same visit.

Microsoft® Excel® was used to capture the quantitative data and Pearson's product-moment correlation coefficient to evaluate the correlation between HbA_{1c} and RBG, with Spearman's rank correlation coefficient as an alternative for non-normally distributed data. A HbA_{1c} level of ≤ 7% was taken to represent good control and > 7% poor control. The sensitivity, specificity, predictive values and likelihood ratios of different threshold levels of RBG were then analysed. In addition, the study population was also examined by means of a receiver operating characteristic (ROC) curve to determine the value of RBG with the best combination of sensitivity and specificity to predict poor control of diabetes. Statistica® version 9 was used to evaluate the data with the assistance of the Centre for Statistical Consultation.

Data were obtained on 349 patients with diabetes, of whom 203 (58.2%) were female and 146 (41.8%) male. The study population had a mean age of 54.7 years (standard deviation 15.2), mean RBG of 13 mmol/l, and mean HbA_{1c} of 9.4%. Of this population, 247 (70.8%) were uncontrolled with an HbA_{1c} > 7%. There was only a moderate, but significant correlation between the RBG and HbA_{1c} results (correlation co-efficient 0.6,

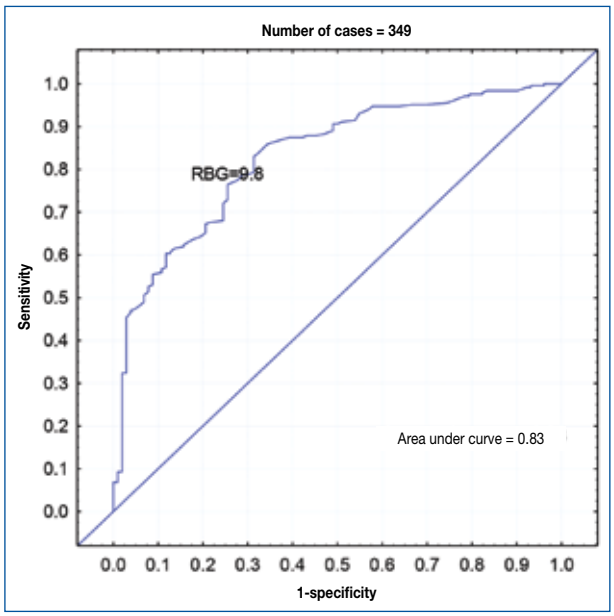

Figure 1: Receiver operator characteristic curve for random blood glucose

p-value < 0.001), which only explained 45% of the variation in RBG. The ROC shown in Figure 1 demonstrates that an RBG of 9.8 mmol/l had the best predictive properties (Table I) to determine the control of diabetes.

If decisions are made on this basis, 23% of 70.8% of patients with poor control will be missed. It implies that of 100 patients seen in the outpatient department, 16 who are poorly controlled will be missed and have a RBG that is less than 9.8 mmol/l. On the other hand, 25% of the 29.2% of patients with good control will be inappropriately labelled as poorly controlled. This implies that of 100 patients, seven will fall into this category and will have an RBG of greater than 9.8 mmol/l when seen. Therefore, overall, a decision made on the basis of RBG would inappropriately categorise 23 of every 100 patients seen. Thus, currently, although decision-making using RBG is based on the best possible cut-off value, almost a quarter of patients would be mismanaged using this system.

Table I: Predictive properties of a random blood glucose threshold of 9.8 mmol/l

Indicator	Result
Sensitivity	77%
Specificity	75%
Positive predictive value	0.88
Positive likelihood ratio	3.08
Prevalence of poor control	70.8%
Pretest odds	2.42
Post-test odds	7.45
Post-test probability	88.2%

In conclusion, the study highlights that a single RBG result should not be relied upon to make a valid decision about the control of diabetes. It is possible that the mean of a series of RBG results taken over time could have better validity. However, this is not current practice and would require a separate study. In view of the problems with the number of patients being tested, and doctors having access to the HbA_{1c} result at the time that the clinical decision is taken, we recommend that point-of-care testing for HbA_{1c} should be explored.[4]

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